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Monitoring Protocol for the Ord's Kangaroo Rat

Alberta Species At Risk Report No. 113

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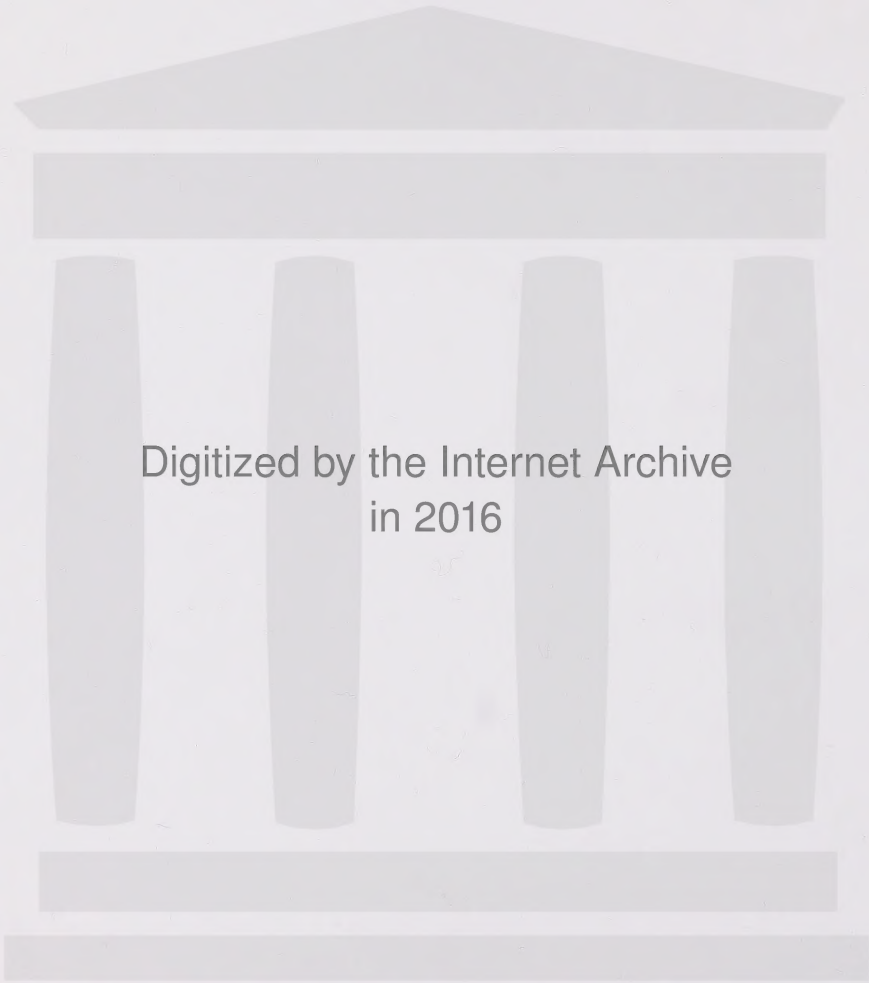
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Monitoring Protocol for the Ord's Kangaroo Rat

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Randy E. Dzenkiw

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EXECUTIVE SUMMARY

The Ord's kangaroo rat is a nocturnal rodent that occurs in Canada as a northern population that is geographically isolated from southern conspecifics. In Alberta, it occurs in the vicinity of the Middle Sand Hills north of Medicine Hat. This population of kangaroo rats is currently recognized as Endangered due to extreme fluctuations such that the population crashes to < 1000 animals in harsh winters.

The Alberta Recovery Plan for Ord's kangaroo rat calls for standardized population monitoring as a high priority recovery activity. The purpose is to establish a long-term database that supports defensible, inter-annual comparisons of distribution, relative abundance, and survival, including: (i) evaluation of population-persistence and rates of extinction and re-colonization of local populations; (ii) quantification of variation and trends in relative abundance; and (iii) estimation of annual survivorship. These measures will be used to direct management activities and to evaluate the relative success of the recovery of this species. This document provides a detailed population monitoring protocol to serve as a guide for implementation of long-term, standardized monitoring for the Ord's kangaroo rat in Alberta.

Natural habitat of kangaroo rats in Alberta includes active sand dunes, blowouts, and eroded slopes of sandy river valleys. These landscape features are naturally patchy and are becoming increasingly rare due to stabilization by vegetation. As natural habitats are disappearing, sandy features created by humans appear to be used opportunistically as surrogate habitat. Typically, these anthropogenic (i.e. human-made) habitats are linear features such as unpaved roads, trails, fireguards or the margins of agricultural fields. Superficially, these sites provide the open, sparsely vegetated ground that kangaroo rats require. However these anthropogenic habitats are believed to be much lower in quality. Both natural and anthropogenic habitats are surveyed in the long-term monitoring program. However, natural sites are denoted highest priority for monitoring because they are believed to play a critical role for conservation of the kangaroo rat population.

This population monitoring protocol document includes: (i) a detailed listing and maps of survey sites; (ii) an outline of required permits and access permissions; (iii) a list of field equipment and supplies; (iv) field techniques for mark-recapture surveys and animal handling/processing; (v) datasheets; and (vi) notes regarding measures to reduce risk of accidental vehicle fires due to the necessity of driving on un-maintained roads and trails. Thus, this protocol document should be a useful resource for the Recovery Team for Ord's kangaroo rats and future field personnel that lead or assist with standardized population monitoring for Ord's kangaroo rat.

The design of the standardized population monitoring program is meant to support analysis of long-term trends; however, even in the first few years of implementation, standardized monitoring will be an important and worthwhile investment because it will assist the Recovery Team and stakeholders with direction and prioritization of population and habitat management activities.

ACKNOWLEDGEMENTS

Long-term population monitoring of Ord's kangaroo rats would not be possible without the financial and in-kind support provided by the Department of National Defence (CFB Suffield), Alberta Sustainable Resource Development (Fish & Wildlife Division), EnCana Corporation, the Royal Alberta Museum, and the University of Calgary. Alberta Sustainable Resource Development and EnCana Corporation provided additional financial support for the preparation of this protocol. D. Bender and D. Gummer would also like to thank the field staff who participated in the first two years of monitoring where these protocols were developed and first implemented: Veronique Arvisais, Randy Dzenkiw, Matthew McBurney, Sandi Robertson, Tara Stephens, Andy Teucher, Stephanie Wahl, and Bill Weimann. We are grateful for permission to use photographs by Sandi Robertson and the Royal Alberta Museum. L. Matthias and A. Todd provided editorial assistance.

1.0 INTRODUCTION

The Ord's kangaroo rat (*Dipodomys ordii* Woodhouse, 1853) is a nocturnal rodent in the family Heteromyidae, which is comprised of primarily granivorous species adapted to arid environments. Ord's kangaroo rat is the most widespread species of kangaroo rats, and the only one found in Canada. At the northern limit of its range, the species occurs in sand hill areas in southeastern Alberta and southwestern Saskatchewan (Figure 1), particularly the Middle Sand Hills (Alberta) and Great Sand Hills (Saskatchewan). The Canadian population is presumed to have been geographically isolated from southern populations for as much as 6000 years (COSEWIC 2006). A number of unique traits, such as large body size, the ability to use daily torpor, and accelerated reproduction, have been studied by Gummer (1997a, 2005) and are believed to be adaptations for surviving in the relatively harsh Canadian climate. Despite these adaptations, over-winter survival can be less than 10% (Gummer 1997a), with estimates of population size in Canada of less than 1000 individuals during spring (COSEWIC 2006). For these reasons, the species is listed as Endangered, both provincially under the *Alberta Wildlife Act* and federally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

The Alberta Recovery Plan for the Ord's kangaroo rat (Alberta Ord's Kangaroo Rat Recovery Team 2005) calls for long-term population monitoring as a priority recovery activity. The purpose is to establish a long-term database that supports defensible, inter-annual comparisons of distribution, relative abundance, and survival, including: (i) evaluation of population persistence and rates of extinction and re-colonization of local populations; (ii) quantification of variation and trends in relative abundance; and (iii) estimation of annual survivorship. These measures will be used to direct population and habitat management activities and to evaluate the relative success of recovery of this species. To ensure that monitoring efforts are consistent and comparable among survey sessions, standardized methods for surveying Ord's kangaroo rats are required. Ideally, standardized monitoring methods should be consistent with respect to population census techniques, timing and location of surveys, and data reporting. This will minimize the chance that among-year variation could result from differences in survey methods rather than actual differences in the population status. Furthermore, it is not logistically possible to survey all habitats that may be occupied by the species, so it is essential that population censuses are surveyed at sites that are representative of the types of habitats and locales occupied by kangaroo rats in Alberta (e.g., active sand dunes, roads, fireguards, and exposed soils in agricultural areas). Finally, it is recognized that in any long-term monitoring program, there will be turnover in the personnel conducting the surveys, particularly if temporary staff perform the actual surveys. Thus, a detailed manual of procedures for conducting surveys and recording results is required.

The purpose of this document is to provide a detailed population monitoring protocol for the Ord's kangaroo rat in Alberta that meets all of the above requirements. While the protocol is designed for use in the long-term monitoring program recommended by the

Alberta Recovery Team for the Ord's kangaroo rat, it could also be used for other purposes (e.g., surveys of other sites, such as those proposed for development, or monitoring other habitats outside Alberta), perhaps with minimal modification.

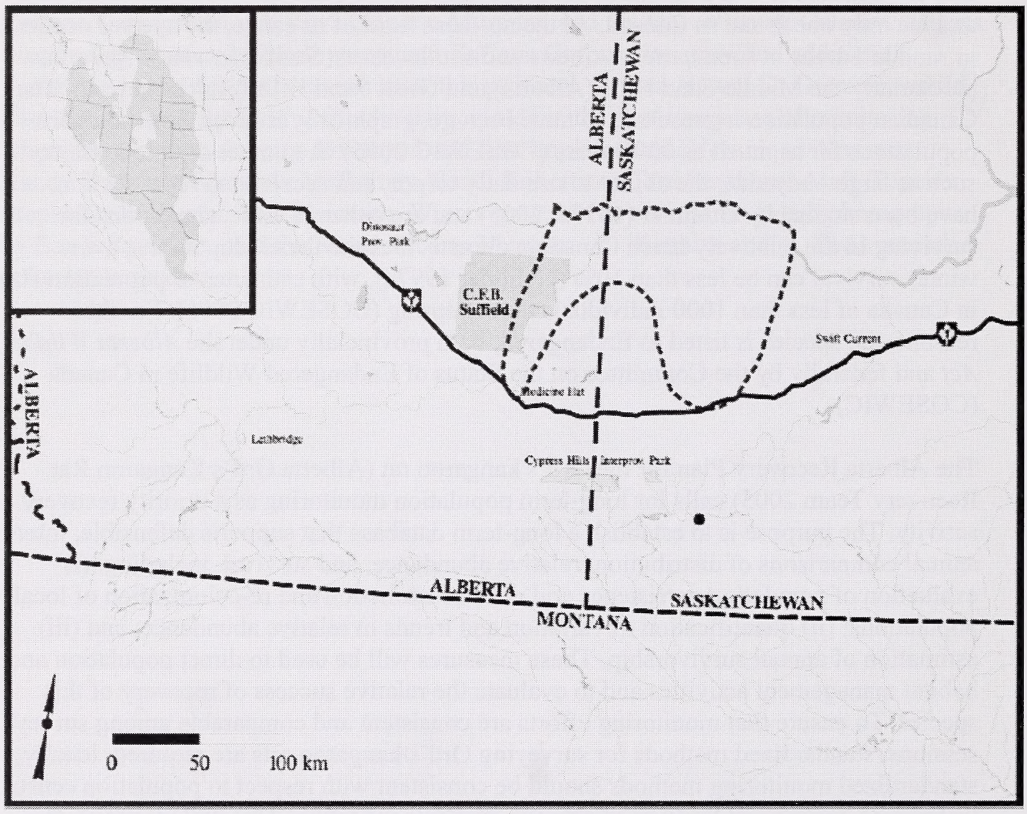

Figure 1. Known range of Ord's kangaroo rats in Canada encompassed by the red dashed border (from Gummer and Robertson 2003). One outlier record (●) near Ravenscrag, Saskatchewan, is presumed to represent an accidental/vagrant. Inset: Species range across North America (from Hall 1981).

2.0 BIOLOGY AND ECOLOGY OF ORD'S KANGAROO RAT

2.1 Physical Characteristics

The Ord's kangaroo rat has typical kangaroo rat body characteristics, with enlarged hind limbs, reduced forelimbs, a long tufted tail, large eyes, external fur-lined cheek pouches, an enlarged nasal structure, and a small-medium body size. Ord's kangaroo rats in Canada are larger than members of this species found elsewhere, possibly an adaptation

to assist thermoregulation in the colder climate (Gummer 1997a). Adults typically weigh between 60 – 80g, with males slightly larger than females. This species of kangaroo rat has five-toed feet and a bicoloured pelage, with white ventral fur and a more conspicuous orange-brown dorsal coat. Other characteristic markings of the pelage include a white stripe above the hind limb, a white patch above the eye and another at the base of the ear, and a white lateral stripes on the dusky tail. Adult Ord's kangaroo rats have a distinctive appearance and are unlikely to be confused with other rodent species that overlap their range in Alberta.

2.2 Habitat

Kangaroo rats are well adapted to arid environments (French 1993), and have highly specific habitat requirements in Canada (Gummer 1997b). Sparsely vegetated areas free from obstructions to jumping are required to facilitate their bipedal locomotion (Yousef et al. 1970). The species also requires loose sandy soils to dig burrows (Gummer 1997b), which are used for shelter and food storage. Natural habitat of kangaroo rats in Alberta includes active sand dunes, blowouts, and the eroded slopes of sandy river valleys (Figure 2). These landscape features are naturally patchy, but they are becoming increasingly rare in recent decades due to stabilization by vegetation (Hugenholtz and Wolfe 2004, COSEWIC 2006). Typically, kangaroo rat occurrences are associated with sand hills and adjacent areas (Figure 3).

As natural habitats are disappearing, sandy features created by humans appear to be used opportunistically, as surrogate habitat. Typically, these anthropogenic (i.e. human-made) habitats are linear features such as unpaved roads, trails, fireguards or the margins of agricultural fields (Figure 2). These are abundant throughout the kangaroo rat range in Alberta. Superficially, these sites provide the open, sparsely-vegetated surface that kangaroo rats require; however these anthropogenic habitats are believed to be much lower in quality. For example, these habitats are proliferated with invasive plant species that may not provide adequate forage for kangaroo rats, they are prone to frequent human disturbances (e.g. traffic, mowing, grading), and they appear to experience higher risk of predation and parasitism than at natural sites (Robertson 2007, Teucher 2007). As a result, anthropogenic habitats are hypothesized to be 'sink' habitats, where kangaroo rat populations experience levels of mortality that surpass recruitment (Gummer and Robertson 2003).

2.3 Behaviour

The Ord's kangaroo rat is primarily nocturnal and individuals move beyond their complex of burrows only on the darkest nights. When foraging, they are usually found collecting seeds in sparsely vegetated habitats or at the margins of open sand. Their habit of following familiar routes each night produces worn runways through the vegetation (Figure 4).

Kangaroo rats spend most of the winter underground in their burrows, surviving on the seed cache collected in warmer months (O' Farrell 1974). Canadian populations use

torpor (shallow hibernation) to conserve energy during winter, an adaptation not observed in any other population of kangaroo rats of any species (Gummer 2005).

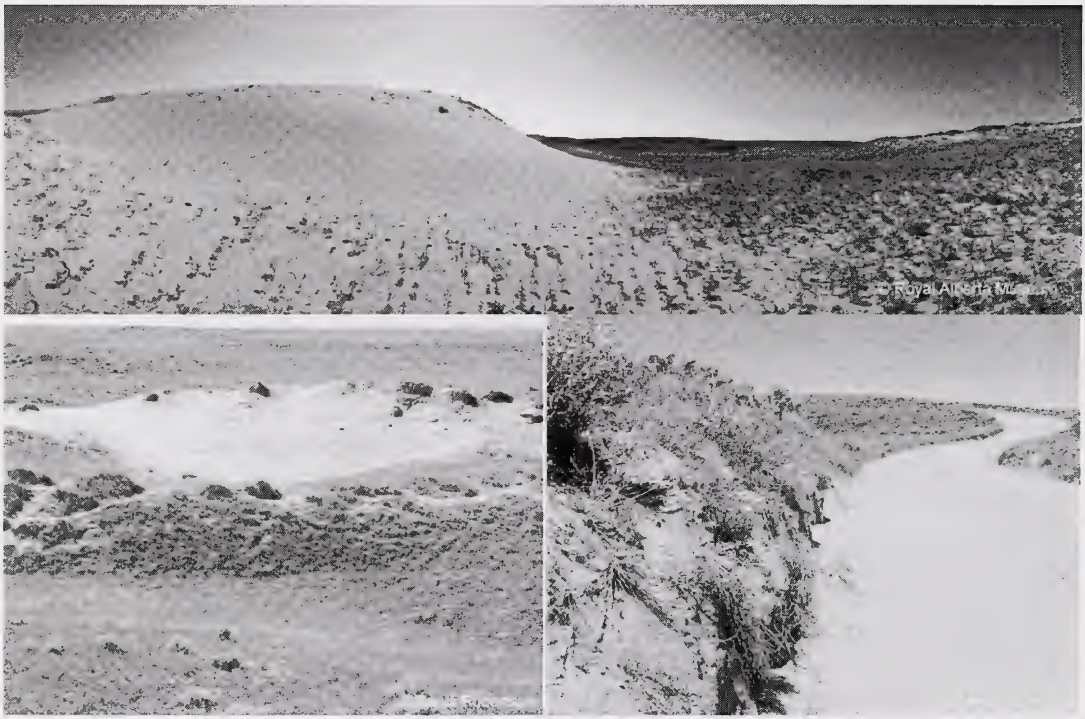

Figure 2. Typical kangaroo rat habitats in Alberta. Top: An active sand dune. Bottom left: A large blowout, which has developed as part of a much larger dune complex. Bottom right: A sandy road that serves as a fireguard.

2.4 Distribution

The population of Ord's kangaroo rat in Canada represents the northern limit of this species' range, which extends south through the Great Plains to central Mexico. Although widespread, populations are localized due to habitat requirements of the species. The distribution of kangaroo rats in Alberta is known to closely follow the Middle Sand Hills (Gummer and Robertson 2003), specifically throughout the eastern portion of Canadian Forces Base Suffield and adjacent areas between the South Saskatchewan River and Red Deer River (Figure 1). This region is characterized by the warmest and driest climate in Alberta, as well as sandy soils and sparsely vegetated grasslands.

Kangaroo rats in Alberta are separated from the nearest southern population in Montana by approximately 270 km (COSEWIC 2006). The South Saskatchewan River is believed to serve as a barrier to populations in Saskatchewan because kangaroo rats are poor swimmers and remain underground for the majority of time that the river is frozen (Gummer and Barclay 1997).

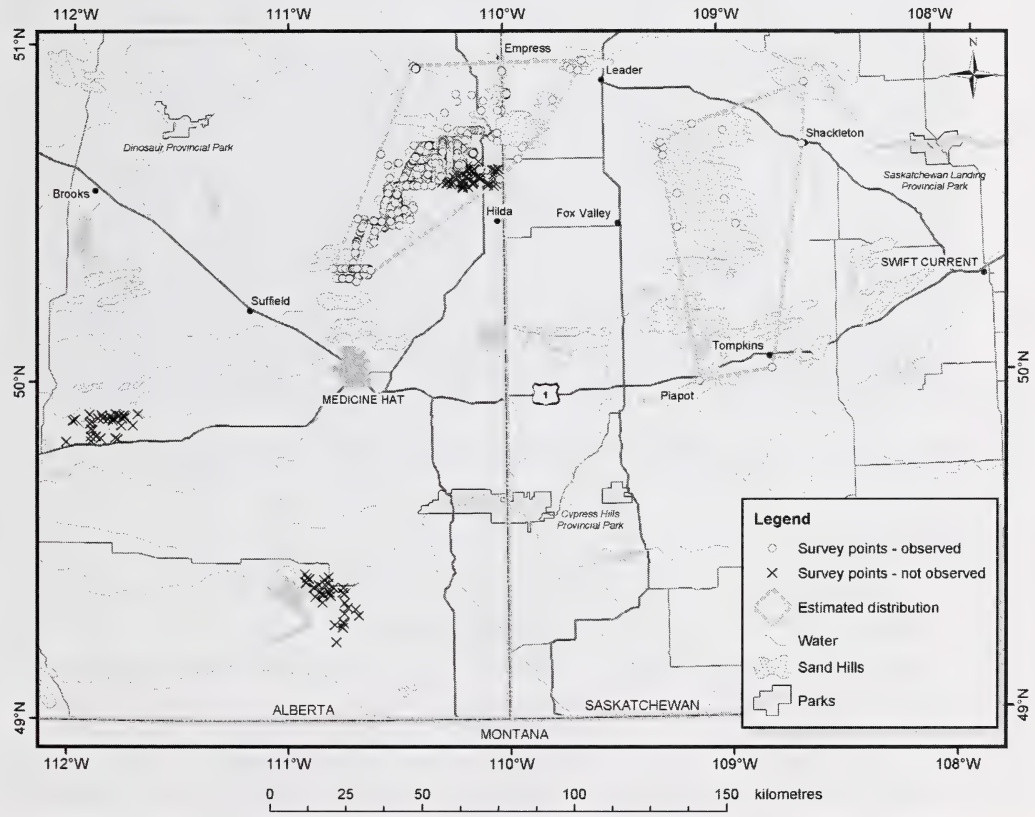

Figure 3. The distribution of Ord's kangaroo rat occurrences and recent surveys in southwestern Saskatchewan and southeastern Alberta. Extent of occurrence is indicated by the minimum convex polygons with the dashed border (COSEWIC 2006). Survey point symbols indicate if they represent confirmed occurrences of kangaroo rats or sites that were searched intensively but did not appear to be occupied (Gummer and Robertson 2003).

Figure 4. Distinctive kangaroo rat runways on a sparsely vegetated sand dune.

3.0 SURVEY PREPARATION

3.1 Site Selection

All survey sites for standardized monitoring of Ord's kangaroo rats in Alberta are located in the vicinity of the Middle Sand Hills. Despite extensive surveys for kangaroo rats in other sand hills of southeastern Alberta, there is no evidence of this species elsewhere in the province (Gummer and Robertson 2003; see Figure 3). Both natural and anthropogenic habitats are surveyed in the long-term monitoring program, and detailed maps of study sites are provided in Appendix A[1].

Natural sites are considered highest priority for monitoring because they are believed to represent source areas for the kangaroo rat population. These high quality habitats include active sand dunes and eroding sand slopes along the South Saskatchewan river valley. Many semi-stabilized sand dunes in the area also have small, isolated patches (< 10 m^2) of partially exposed sand that may occasionally be used by kangaroo rats. However these small areas that are infrequently occupied are not sampled by this survey protocol because they appear to represent such a minor component of the population and

[1] Maps detailing the location of individual study sites are not provided in the public version of this document to protect the sensitive nature of these locations.

would be costly and impractical to survey. Natural sites are always surveyed on foot using high-powered flashlights to locate individual kangaroo rats (see section 4.0 SURVEY METHODS below).

Anthropogenic sites include unpaved roads, trails, and fireguards that occur on or adjacent to soils of high sand content. Currently, only sites that have been known to support kangaroo rats in the past 12 years are monitored. Note that previous surveys conducted by D. Gummer have revealed that the use of road segments is not consistent among years. It appears that these anthropogenic habitats may support high numbers of kangaroo rats in one year, only to crash and support few or no kangaroo rats during subsequent years. Thus, over the long term, anthropogenic sites tend to support low densities of kangaroo rats, and are often ephemeral in nature. For these reasons, anthropogenic sites hold lower priority for monitoring than natural sites. Anthropogenic sites, particularly roads, trails and fireguards, are typically surveyed by vehicle to maximize search effort (see section 4.0 SURVEY METHODS below).

At the time of writing, there were 20 natural sites and 17 anthropogenic sites being monitored in the standardized monitoring program. While maintaining a consistent effort of monitoring at these sites is essential for comparing population trends among years, the monitoring program must also be flexible to accommodate changes to the habitat of the kangaroo rat. In Alberta, kangaroo rat habitats are highly dynamic. For example, active sand dunes in the Middle Sand Hills are stabilizing quickly (estimated at 40% per decade, see COSEWIC 2006), representing considerable loss of habitat for kangaroo rats. Alternatively, new developments may create new roads or trails, initiating new anthropogenic habitats that may support kangaroo rats. Thus, the current list of sites can be modified in future years to accommodate the loss or creation of habitat. However, the sites should not be modified in response to fluctuating distributions of the population because this is recognized as an inherent and important characteristic of Ord's kangaroo rats in Alberta and should be captured by the standardized monitoring program.

3.2 Permissions

Various permits and permissions are required to conduct surveys on federal and provincial lands within the range of the Ord's kangaroo rat in Alberta. Alberta research and collection permits are required for surveys, and can be obtained from the Alberta Fish and Wildlife Division, Sustainable Resource Development. To obtain the research permit, the research proposal must first have been granted animal care certification, either through the Alberta Fish and Wildlife Division, or from a recognized animal care committee following the guidelines of the Canada Council for Animal Care (CCAC).

For work on federal lands, a Species at Risk Permit (Scientific Research) must be obtained from Environment Canada[2]. Access to Department of National Defence lands on CFB Suffield requires that all personnel are approved for access by the Base Commander or their delegate, and that they complete range safety training and acquire a range access permit. In addition, surveys conducted within the CFB Suffield National Wildlife Area also require approval and a permit, which will only be issued if a provincial research permit and a federal Species at Risk Permit have been obtained. CFB Suffield Range Access and NWA Access Permits can be requested from the G3 Range Control office at CFB Suffield.

For work on privately owned or leased lands, the permission of the landowner/lease-holder must be obtained prior to accessing their lands to conduct surveys. Given that species at risk legislation is still relatively new to many private land holders, and that there are often sensitivities regarding the presence of protected species on private lands, it is recommended that a member of the Alberta Recovery Team for the Ord's Kangaroo Rat is consulted prior to seeking permission to conduct surveys on private or leased lands.

3.3 Equipment Needed

The following is a checklist of equipment and materials required to conduct kangaroo rat surveys in natural and anthropogenic habitats:

- Blank data sheets to record information about environmental survey conditions, kangaroo rat captures, and kangaroo rat observations (provided in Appendices B, C, and D).
- Clipboard to hold the data sheets (necessary on windy nights).
- Pencils for recording data (preferably mechanical).
- Topographic map and CFB Suffield range calendar (required for accessing CFB Suffield lands).
- Soft leather or thick-cotton gloves to protect hands from occasional bites by kangaroo rats.
- Leather work gloves (recommended) to protect hands from speargrass and hot areas when cleaning vegetation from the undercarriage of the vehicle (see Appendix E – Vehicle Fire Safety).
- Headlamp or other hands-free light source and batteries; required for handling and processing captured kangaroo rats or note-taking.
- High-powered flashlight such as a 4 D-cell Maglite flashlight (Mag Instruments, Inc., Ontario, CA) and batteries—used for locating kangaroo rats while on foot.

[2] At the time of writing, a federal Species At Risk Permit was not actually required because the Ord's kangaroo rat had not been added to Schedule 1 of the Species At Risk Act. However, it is anticipated that this will likely occur in 2007 based on the COSEWIC re-assessment of the species as Endangered in Canada. Once the species has been added to Schedule 1, federal Species At Risk Permits will be required to conduct research on the Ord's kangaroo rat.

- 12V Spotlights for locating kangaroo rats while performing vehicle surveys [e.g., 12 V, 'Max Million' Brinkmann spotlight (Brinkmann Corp, Dallas, TX)]. One million candlepower spotlights are recommended.
- Rechargeable spotlights are not recommended for vehicle surveys because of their additional weight and short battery life.
- Cloth catch bags (approx 6 x 10") with a tie strap are used to safely and securely hold captured kangaroo rats.
- Thermometer, preferably digital or alcohol, for reading ambient air temperature.
- Handheld global positioning system (GPS) and batteries—for determining location at capture sites or for navigation. Units should be set to record UTM coordinates using the WGS84 datum, and must be capable of storing tracklogs, user waypoints, and time of waypoint acquisition. Units that can be linked to a personal computer for waypoint retrieval are necessary. Previous surveys have used Garmin 12CX handheld GPS units (Garmin Ltd., Olathe, KS) with GPS Utility 4 software (GPS Utility Ltd., http://www.gpsu.co.uk).
- Spring scale for measuring mass of kangaroo rats: Pesola brand scales (Baar, Switzerland) in the 150 g capacity.
- Sequentially numbered metal ear tags and applicator for uniquely marking kangaroo rats: 7 mm monel ear tags (model 1005-1) and applicator (model 1005s1) from National Band and Tag (Newport, KY).
- Passive integrated transponder (PIT) microchips, applicator and scanner (recommended): a more reliable but expensive alternative to ear tags for uniquely marking kangaroo rats. Personnel must be trained by a veterinarian or other expert to use this equipment. Equipment from Advanced ID Corp./Avid Canada (Calgary, AB) has been used in previous surveys, and the following is suggested: 12 mm FECAVA microchips, MUSICC applicator system (ethanol sterilized AVID syringe with 12 gauge needles and carousel dispenser), and Mini-tracker or Power Tracker V microchip scanners.
- Clear plastic 30cm ruler for measuring tail length. Trim the edge of ruler such that the 0 cm mark is at the very end of the ruler.
- Collection vials to store seeds and botfly larvae collected from kangaroo rats (1/2 oz plastic vials with screw-cap lids are preferred).
- VHF Radio tuned to military Range Control frequency for establishing and maintaining contact with CFB Suffield staff while working on military lands (required). Radios can sometimes be borrowed from CFB Suffield, or permission may be obtained to use a private radio on their radio network.
- Cellular phone to maintain communications with Range Control at CFB Suffield when conducting surveys away from the vehicle radio while on military lands.
- Sturdy footwear (recommended) with leather uppers and a heavy sole are required to protect feet from cactus plants, which are common in kangaroo rat habitat. Boots with ankle support will help on the steep river valley slopes.
- Clear plastic freezer bags can be used as a rain shield when taking field notes (place clipboard, notebook, map, etc. inside plastic bag); also used to collect carcasses if dead kangaroo rats are found.

4.0 SURVEY METHODS

There are two critical periods for conducting population censuses of Ord's kangaroo rats in Alberta: spring (typically mid-April to early June) and mid- to late-summer (late July to early September). Spring and summer censuses are designed to record the minimum and peak population sizes each year so that population fluctuations and over-winter survival (a bottleneck for the population) can be estimated.

Mark-recapture surveys are the preferred method for population censuses. Surveys are always performed with a crew of 2 or 3 surveyors. The goal of the survey at a site is to capture, identify or mark, and record characteristics for all individual kangaroo rats observed to be active above ground. This information is useful for understanding the distribution, size, and health of the kangaroo rat population. Environmental conditions (such as ambient light or temperature) affect the activity of the kangaroo rats; therefore surveys are only conducted when environmental conditions are not limiting (see Section 4.1 below).

Surveying for kangaroo rats is performed in two ways depending on the habitat type: anthropogenic sites, which are typically roads, trails and fireguards, are generally searched by vehicle to maximize search efficiency; natural sites are typically searched on foot. Survey methods for each habitat type are described in Section 4.2 below. In each case, the survey effort for each site is recorded (using a GPS tracklog) as the distance searched by the survey crew. The results of the survey are reported in number of individual kangaroo rats/km searched, which provides a useful index of the abundance of kangaroo rats at the site.

4.1 Survey Conditions and Site Priority

Many factors will affect both the activity of kangaroo rats, as well as the search efficiency of the survey crew. Under adverse conditions (e.g., rainfall, cold temperatures, or the presence of ambient light, such as moonlight), kangaroo rats will restrict their activity above ground. Consequently, surveyors will encounter fewer kangaroo rats, potentially underestimating the relative density of individuals at a site. Additionally, adverse conditions (e.g., heavy rain) may also affect the surveyor's ability to detect kangaroo rats, further contributing to potential underestimation.

Ideally, surveys should be conducted when environmental conditions (e.g., ambient light, precipitation, temperature) are not limiting. Realistically, this is not always possible because there are a limited range of dates on which surveys can be conducted. Therefore, the most efficient use of the survey team is to prioritize the most important sites for nights when environmental conditions are favourable. The current list of sites (Appendix A) lists their survey priority, which was developed on the basis of habitat type (natural sites are highest priority), size, historical occupancy, and abundance. This priority system ensures that sites that are believed most important to the persistence of the Alberta kangaroo rat population (e.g., a large, naturally eroding sand dune with many individuals and high historical occupancy) will always get the highest priority for

surveying. Conditions permitting, lower priority sites will also be surveyed. If all sites in the list are surveyed in one session (typically a 2.5 week period centred on the date of the new moon), then sites will be revisited in order of their priority, and the results from the two surveys averaged for that session. Sites may also be surveyed a second time in a session if it was deemed that the initial survey did not seem representative (e.g., fewer than expected kangaroo rats were observed because the weather became adverse half way through the survey). In this case, a successful second survey would *replace* the first. The use of repeat surveys should be flexible and at the discretion of the survey team.

Three important environmental factors that will negatively affect a survey are described below.

4.1.1 Ambient light

Fewer kangaroo rats appear to be active when there is significant ambient light, such as during a bright moon or intense northern lights. When animals are active above ground, they tend to stay near their burrow entrances and flee to cover quickly. Observing and catching kangaroo rats by hand becomes noticeably more difficult under these conditions. To reduce the effects of a bright gibbous moon, surveys will be conducted during a 17 day period centred on each new moon. In general, if you can see your shadow, it is too bright for a high quality survey. This applies to twilight as well. Arrival to and departure from study sites should be planned accordingly.

Heavy cloud cover can significantly reduce ambient light, and surveys conducted under moonlight will benefit greatly when conducted on overcast nights. On partly cloudy nights when the moon is fairly bright, but covered intermittently by clouds, it is best to focus on large, perhaps lower priority sites. This allows the surveyors to stop and go as the moon appears and disappears, and removes the risk of traveling between sites when the moon was covered (thus wasting good survey time).

4.1.2 Precipitation

Kangaroo rats will very rarely be found outside their burrows if it there is heavy rain or snow. Also, pools of water or a thick layer of snow can impede their bipedal locomotion. They do not seem adverse to saturated soil, wet vegetation, or a thin layer of fresh snow, and can often be seen emerging from their burrows within a few minutes of precipitation. As a good rule of thumb to judge if the precipitation will affect the quality of the survey, if windshield wipers are needed to drive, kangaroo rat activity and the surveyors' ability to observe kangaroo rats will be greatly reduced.

If survey conditions are favourable but rain or snow is threatening, choose to survey small sites. There is a chance that the survey will be completed before

precipitation begins. Also, if precipitation forces the survey to end abruptly, less effort will have been lost.

4.1.3 Cold temperatures

A drop in temperature will not have as strong a negative effect as precipitation or light, but it will reduce the quality of the survey. If the temperature drops below 5°C, kangaroo rats are unlikely to be surveyed effectively.

Typically, night-time temperatures will be lowest just before sunrise. On cold nights, the highest priority sites should be surveyed early in the night, leaving the lower priority sites for when the temperature drops.

Cold nights are especially common during early spring, and conducting quality surveys at all sites can be difficult during these months. One approach is to conduct surveys at small sites before the temperature falls, finish for the night, and leave larger sites for the possibility of warmer weather in subsequent nights. Another alternative, although less preferable, is to sub-sample large sites into smaller units that can be surveyed before the temperature falls. This could include one-way surveys of roads or surveying half of a route.

4.1.3 Recording survey conditions

For each visit to a study site, environmental conditions are recorded (datasheet Appendix B) at the start of the survey, every hour thereafter, and again at the end of the survey. If the survey takes less than one hour, then only the start and end conditions will be recorded. When following a route consisting of multiple road sites, the start and stop times used should be recorded for each study site, not for the entire length of the route. Thus, each road site will have two start times and two stop times (one for each direction of travel up and down the site). Using this method, the stop conditions at one road site will typically be the same as the start conditions for the next road along the route if those two roads segments connect.

The environmental conditions recorded include:

- Date – Current date (remember to increment date after midnight passes).
- Site name – Use proper site names assigned to sites in Appendix A.
- Time – Record the time at which the environmental conditions were observed (hourly, plus while starting or stopping survey activity at a site).
- Air temperature – Allow the thermometer to equilibrate before taking a reading. To obtain an accurate reading of air temperature, avoid laying its temperature sensitive surface in direct contact with the ground or vehicle.
- Wind speed is recorded on a categorical scale.
    i. Calm: no consistent wind.
    ii. Light: wind is consistently present.

iii. Gusty: varying wind speed, with periods of strong and light wind speed.
iv. Strong: a sustained strong wind.

- Cloud cover is also recorded categorically:
  i. None: mostly clear
  ii. Partly: a mix of clear sky and cloud cover
  iii. Cloudy: mostly overcast
- Visibility of the moon – Even if the moon is up, it may be obscured by clouds or terrain. Moon phase can be determined from the date, and entered into the electronic database at a later time.
- Miscellaneous environmental conditions, especially those that may affect survey quality (such as precipitation).

4.2 Survey Methods for Natural Habitat

Natural sites are surveyed on foot with the aid of a bright flashlight and headlamp. The surveyor walks slowly and quietly, scanning for kangaroo rats that are active above ground. Care must be taken to avoid stepping on a kangaroo rat as they are not likely to be noticed if not directly in the light. Care should also be taken to avoid stepping on their burrow entrances. Locating footprints, burrows, runways, or clipped vegetation are good signs that a kangaroo rat might be nearby, and it is common to find a kangaroo rat hopping along a runway. Once a kangaroo rat is found, it can usually be picked up by hand if approached swiftly and quietly.

4.2.1 Sand dunes and blowouts

Active sand dunes and blowouts are discrete entities on the landscape; both provide an area of open sand. Ideal kangaroo rat habitat typically includes just the margin of an open sand face, and extends into the partially vegetated surroundings. As a result, the distinctiveness of a dune and blowout can become lost in the dark of night to anyone unfamiliar with the site. Surveyors should visit each dune or blowout study site at least once in the daylight to become familiar with the terrain. It is useful to record the GPS coordinates of open sandy regions or signs of kangaroo rat activity (such as runways, tracks, burrows, and clipped vegetation), which can then be used as a reference during the night surveys until familiar with the layout of the dune or blowout region.

The first survey should follow that evening, while the mental image of the area is still fresh. Surveyors should search independently and attempt to cover different ground, if possible. The paths that surveyors take while surveying dunes is at the discretion of the surveyor, but care should be taken to cover as much habitat as possible without doubling-back or retracing search paths. By monitoring the tracklog on a GPS device, a surveyor can judge whether the major features of the site are covered and hence avoid retracing the search path.

4.2.2 River valleys

River valley sites are natural sites similar to actively eroding dunes, except that they are actual remnants of a dune field that migrated eastward down the South Saskatchewan River valley. They remain sparsely vegetated due to the steep incline that destabilizes the soil. These sites typically face south or southeast and receive considerable sunlight, which promotes dry soil conditions that help to keep the site from being stabilized by vegetation.

Typically, river valley sites are large areas with no distinct boundary, have multiple ridge features transverse to the slope, and are characterized by terrain that can change dramatically over short distances. Even an experienced surveyor can become disoriented at night without a GPS device.

To ensure that the important areas are surveyed consistently, a GIS should be used to create a survey track that follows the exposed sandy slopes visible from high resolution imagery (e.g. 2.5 m resolution SPOT 5 panchromatic imagery or aerial photos). If unfamiliar with the site, locations of high capture density from previous years may be a useful guide during this procedure. The surveyor should use this track as a guideline to find good habitat, but not hesitate to expand the search where warranted (e.g., to follow kangaroo rat runways or other promising features).

4.3 Survey Methods for Anthropogenic Corridors

Linear habitat provided by roads, trails, fireguards, or the margins of agricultural fields fall under this category. Since most of these features stretch for many kilometres, foot surveys are impractical. These sites are surveyed from a vehicle while driving slowly (< 25 km/h), with the aid of the headlights and handheld 12V spotlights. Flashlights will not provide enough illumination to locate kangaroo rats from the vehicle. Care must be taken to avoid hitting kangaroo rats with the vehicle as they sometimes leap out of cover in nearby vegetation. The spotlights are used to scan the edge of the road for a kangaroo rat. Once located, the vehicle is stopped and one surveyor will illuminate the kangaroo rat while the other(s) approaches the animal on foot to capture it by hand.

Each section of road is searched twice per survey, once in each direction. Covering the same ground twice is necessary because detection is more difficult from a vehicle.

Time often permits multiple roads to be surveyed in a night. In this case, roads in close proximity should be linked into one route which can be followed to its end before doubling back. This is more efficient than surveying one road in each direction before continuing to the next road, which would require covering the same ground three or four times. If low priority roads serve as routes between higher priority sites, they can be surveyed as well, at the discretion of the surveyor.

4.4 Other Survey Methods

4.4.1 Kangaroo rat observations without capture

Observations of kangaroo rats are not as informative as a kangaroo rat capture, but still provide useful information on the population status and should be recorded. Such observations include the sighting of a kangaroo rat that was not captured or one that escaped from capture before it could be examined and marked.

The date, time and location (site name and GPS coordinates) are recorded (datasheet attached in Appendix C), as well as any information that might be useful in identifying the individual, such as the side of the road observed, whether it had an ear tag, or whether it escaped to a burrow.

4.4.2 Track and burrow surveys

While night-time mark-recapture surveys on foot or by vehicle are the typical method for conducting population censuses of Ord's kangaroo rats, occasionally it may be useful to conduct daytime searches for kangaroo rat burrows and tracks. This type of survey yields less information than mark-recapture surveys, but it is useful for establishing the presence of kangaroo rats at a site, and may also help to determine the distribution of kangaroo rats in an area.

Track and burrow surveys should be conducted on foot in the early morning or on particularly calm days, when tracks and burrows are well preserved in loose, dry sand. Surveyors need to search for characteristic burrows with runways (Figure 5) accompanied by distinctive paired footprints and tail drags (Figure 6).

5.0 METHODS FOR PROCESSING CAPTURED KANGAROO RATS

5.1 Handling

Once a kangaroo rat is captured by hand, it should be placed immediately in a catch bag. The animal will calm while in the bag, minimizing the risk of capture myopathy (a condition in which wild animals die from stress during handling). This also allows the surveyors to prepare the equipment needed for processing.

The kangaroo rat is usually docile once removed from the bag, struggling only if physically restrained. When released from its hold, the usual response from a kangaroo rat is to just sit calmly in your hand. Thus, minimal restraint should be used during processing to reduce stress on the animal.

Figure 5. Photograph of an Ord's kangaroo rat burrow with runways.

Figure 6. Photograph of Ord's kangaroo rat paired footprints and tail drags in sand.

5.2 Processing

Processing a captured individual is a three step procedure: marking the animal; recording information about the kangaroo rat; recording information about the conditions of capture.

5.2.1 Marking

Each kangaroo rat is uniquely marked so that it will be recognized if captured again. Recapture information is used to estimate population-level information, such as population size and survival. It is also useful for tracking the fates of individuals through time (following successive recaptures).

Once removed from the catch bag, a kangaroo rat should immediately be marked with an ear tag and/or microchip before it is processed further. If the kangaroo rat escapes before processing is complete, at least it will be possible to identify that individual, if recaptured.

An ear tag is a simple metal clip which has a unique serial number engraved in it. The tag is clipped into the ear with a specialized applicator that looks and is handled similarly to a pair of pliers.

A passive integrated transponder (PIT) microchip is another tool used to uniquely identify an animal. It is a rice-sized (12 mm) capsule injected subcutaneously with a specialized syringe. It is more difficult to administer than an ear tag and is much more expensive. However, it has proved more reliable than ear tags, which can sometimes be torn out. The serial number of a microchip can be read using a microchip scanner, which is a hand-held device capable of detecting an embedded microchip and determining serial number, by simply passing it over the animal. Due to the invasive nature of embedding microchips into kangaroo rats, the use of microchips to mark animals should only be performed by personnel trained by a veterinarian or other expert that is experienced with the technique on small animals.

5.2.2 Information on individual kangaroo rats

Most information about the kangaroo rat should be recorded after it is marked (datasheet attached in Appendix D). However, two steps can be taken while it is still safely in the catch bag:

- Weigh the catch bag with the kangaroo rat inside. Upon releasing the animal, weigh the empty bag to calculate the animal's weight.
- Scan the kangaroo rat within the bag for a microchip.

After marking is completed, the following information is collected on the kangaroo rat:

- Visually inspect the condition of its ears. Tears and nicks can be helpful identifiers of torn-out ear tags, and are also an indicator of the animal's condition, activity, and age.
- Feel the cheek pouches carefully and note if they are empty. If possible, identify the contents. Seeds have a particular texture that can be recognized even if felt through the animal's cheeks. Often the kangaroo rat will expel any contents while inside the catch bag or when first caught. These should be collected in a vial labelled with the location, ear tag and/or microchip code, date and time.
- Search animal's pelage and skin for parasites such as fleas, mites, ticks and botfly larvae. Record the intensity of parasitism. Botfly parasitism is of particular importance, so take detailed notes on the number, location, and stage of any larvae present.
- Hold the kangaroo rat upside down to determine its sex and reproductive status. Several indicators can be used to determine reproductive status (Gummer 1997a). Males will be non-active or active, the latter being when the testes are descended from the abdominal cavity. Females can be non-active, estrous (inflammation of the vulva), recently mated (with a copulatory plug), late pregnancy (large body mass and swollen abdomen), lactating (red swollen mammae prominent), or post-lactating (white worn mammae prominent). Juveniles and some non-active adults can be difficult to sex; the best indicator is the urogenital distance (smaller for females than males; Martin et al. 2001).
- Determine age as juvenile (born that year) or adult. This can be difficult late in the summer when juveniles reach adult size and sexual maturity. Recognition of such juveniles comes with experience, but look for a less established 'paintbrush' on the tip of the tail, disproportionately large feet, and unscarred ears as good indicators. Sexually active juvenile males will typically have smaller testes than active males.
- Tail length is a useful proxy measurement for overall skeletal size, and is used in combination with body mass to provide an index of body condition (described by Teucher 2007). The tail measurement is made with a clear plastic ruler from the tip of the tail (do not include tuft of hair) to where the tail meets the body. Hold the tail straight against the ruler, while shining a headlamp through the fur towards the reader, to locate the tip of the tail.
- Miscellaneous notes, such as identifying scars, or interesting behaviour.

5.2.3 Recording capture conditions

To minimize the handling time of the kangaroo rat, survey conditions should be recorded after it is released. Information recorded includes:

- New or recapture. If the kangaroo rat does not have an ear tag or microchip, it is assumed to have not been caught before. Torn-out ear tags leave a characteristic tear in the ear, in which case a note should be made that it is a possible recapture, which may be identified from the database (considering location of capture and identifying characteristics of the animal).
- Names or distinguishing initials of the surveyors involved in the capture of this kangaroo rat.
- Date (actual) and time of capture.
- Site name. Each study site has a unique name that should be recorded.
- Survey method used (foot or vehicle survey).
- If captured on a road or trail, record which side the kangaroo rat was first observed on (e.g., north or south).
- GPS coordinates and the name of the waypoint storing this information. Coordinates for kangaroo rat surveys in Alberta are recorded with the Universal Transverse Mercator (UTM) projected coordinate system in the WGS84 datum, typically with an error of ±10 m.
- Temperature, wind speed, cloud cover, moon visibility and other environmental conditions, as for the survey protocol. Allow time for the thermometer to equilibrate by setting it out before processing the kangaroo rat.

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APPENDIX A – Detailed Maps of Long-term Monitoring Study Sites

(Detailed maps of the long-term monitoring study sites are not provided with the public version of this document to protect the sensitive nature of their locations.)

APPENDIX B – Environmental Survey Conditions Form

(printed on next page)

Environmental Survey Conditions Form

Date	Time	Site	Temp	Wind	Cloud	Moon	Other

APPENDIX C – Ord's Kangaroo Rat Observations Form

(printed on next page)

Ord's Kangaroo Rat Observations

Date	Time	Site	Side	Waypnt	Easting	Northing	ET?	Esc.to Burr?	Notes

APPENDIX D – Ord's Kangaroo Rat Capture Form

(printed on next page)

OKR Capture

New / Recapture

Rat ID:

Surveyors:

Date:

Time:

Site:

Method: **Side of road:**

UTM Waypoint: _____

Easting:

0						

Northing:

Temperature:

Wind speed: Calm Light Gusty Strong

Cloud cover: None Partly Cloudy

Moon visible? Y / N

Other conditions:

Ear tag #:

Microchip #:

Ear condition: L

R

Anything in cheeks? Y / N **Collected?** Y / N

Contents (seeds, bedding, etc):

Weight (g): **Tail length (mm):**

Age: **Sex:** **Reproductive status:**

Parasites Y / N

Fleas:

None Mild Heavy

Other parasites:

Bots: Y / N **Number:**

Description (e.g. locations, stages, condition):

Notes:

APPENDIX E – Vehicle Fire Safety

The primary strategy to reduce the chances of an accidental vehicle fire is to minimize off-road driving during periods of high fire risk. Carefully plan to use the most direct vehicle access routes with the least vegetation and by accessing survey sites on foot where feasible. However, several remote survey sites will still necessitate some driving on un-maintained roads or trails. Often, these routes have substantial vegetation (especially grass) growing between the tire tracks. Typically by late spring, the grass will have grown tall enough to reach the undercarriage of the vehicle. Special care should be taken to prevent the accumulation of vegetation near hot vehicle parts, particularly the catalytic converter and exhaust system, that can produce a fire.

The following is recommended as minimum safe practice to prevent a vehicle fire when travelling off-road or on un-maintained trails:

- Use a vehicle with high clearance, few body effects, and an open undercarriage to reduce the likelihood of accumulating vegetation underneath the vehicle. A vehicle with plenty of clearance also makes it easier to get under the vehicle to remove vegetation. Four-wheel drive (4x4) vehicles typically have the best clearance, and full-sized pickup trucks are generally superior to sport utility vehicles (SUVs) for this purpose. All-wheel drive vehicles and SUVs should be avoided unless they are outfitted with over-size tires and have at least 8" of clearance to the undercarriage.
- Keep a dry chemical fire extinguisher and a water pump extinguisher in the vehicle at all times. The dry chemical extinguisher should be a 10 lb multi-purpose (Class ABC) extinguisher that can be used to extinguish fires that ignite under the vehicle. The water pump extinguisher should be a 5 gallon (20 l) backpack style extinguisher with a hand-operated pump that can be used to extinguish burning grass or other vegetation. It is recommended that a wetting/foaming agent be used in the water tank.
- The vehicle should be driven at most 15 km/h when off-road or on un-maintained trails. Above this speed tall vegetation no longer sweeps the bottom of the vehicle, but begins to collect in the undercarriage due to snagging and breaking of the grass stems. Significant accumulation of dry grass or other vegetation in the undercarriage will produce a vehicle fire if the materials get hot enough.
- Avoid driving along deeply rutted tracks that bring the vehicle's undercarriage close to the hump in the middle of the track, possibly collecting any vegetation located there.
- When stopping or parking on a trail, find an area that has lower and sparser vegetation. Remove vegetation that is touching the undercarriage, especially around the engine and exhaust system. If there is too much vegetation to remove, or if it cannot be reached, use the water pump extinguisher to thoroughly spray the vegetation and hot areas of the undercarriage (but avoid spraying the engine block).
- Upon returning to a road or other flat area, immediately check under the vehicle for any accumulations of vegetation. Remove all vegetation before continuing. Resuming road speeds will fan any embers or smouldering vegetation and potentially ignite a fire. Many vehicle fires actually ignite after leaving the trail and resuming road speeds, and not while travelling through the vegetation.

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